

THE ENGLISH
CRETACEOUS TURRITELLIDAE
AND MATHILDIDAE (GASTROPODA)

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THE ENGLISH CRETACEOUS TURRITELLIDAE AND MATHILDIDAE (GASTROPODA)

By H. L. ABBASS

SYNOPSIS

The paper is a systematic study of the Turritellidae and other *Turritella*-like gastropods found in the Cretaceous rocks of England. The number of species recognized is 13, of which the following are described as new: *Turritella* (*Torquesia*) *tamra*, *T. (Torquesia) wagihi*, *T. (Torquesia) faizai*, *T. (Torquesia) hassani*, *Turritella* (s. lat.) *ageri*, *Turritella* (s. lat.) *sherborni*, *Mathilda coxi*, *M. ahmadi*. Formations of Albion age (the Blackdown Greensand and the Gault) have yielded the greater number of the gastropods described, but some species come from the Aptian, Cenomanian, and Senonian.

INTRODUCTION

THE work which has led to the present paper was carried out in 1954-6 in the Department of Geology of the Imperial College of Science, London, in partial fulfilment of the requirements for the degree of Ph.D. of the University of London. The author has received advice and help from several people, and is especially grateful to Dr. L. R. Cox, of the British Museum (Natural History), and to Dr. D. V. Ager, of the Imperial College, in this connection. The material examined belongs to the collections of the Department of Palaeontology of the British Museum (Natural History), the Geological Survey of Great Britain, the Sedgwick Museum (Cambridge), Mr. C. W. Wright, and Dr. J. M. Hancock. The writer tenders his thanks to these two gentlemen and to the authorities of the institutions mentioned for the facilities afforded him to carry out the work.

STRATIGRAPHICAL NOTES

Fossil turriculate gastropods occur in several of the English Cretaceous marine formations. They are, however, known only from a relatively few localities and are rarely abundant, so that there is no possibility of their being used stratigraphically. Most of the material described in this paper comes from old museum collections and in some cases nothing is known of the precise horizons and localities from which the specimens were collected. There is a probability that in some cases specimens with similar labels (e.g. "Gault, Folkestone") may come from a whole range of horizons within the formation stated.

The marine Neocomian rocks found in Lincolnshire and Yorkshire have yielded no

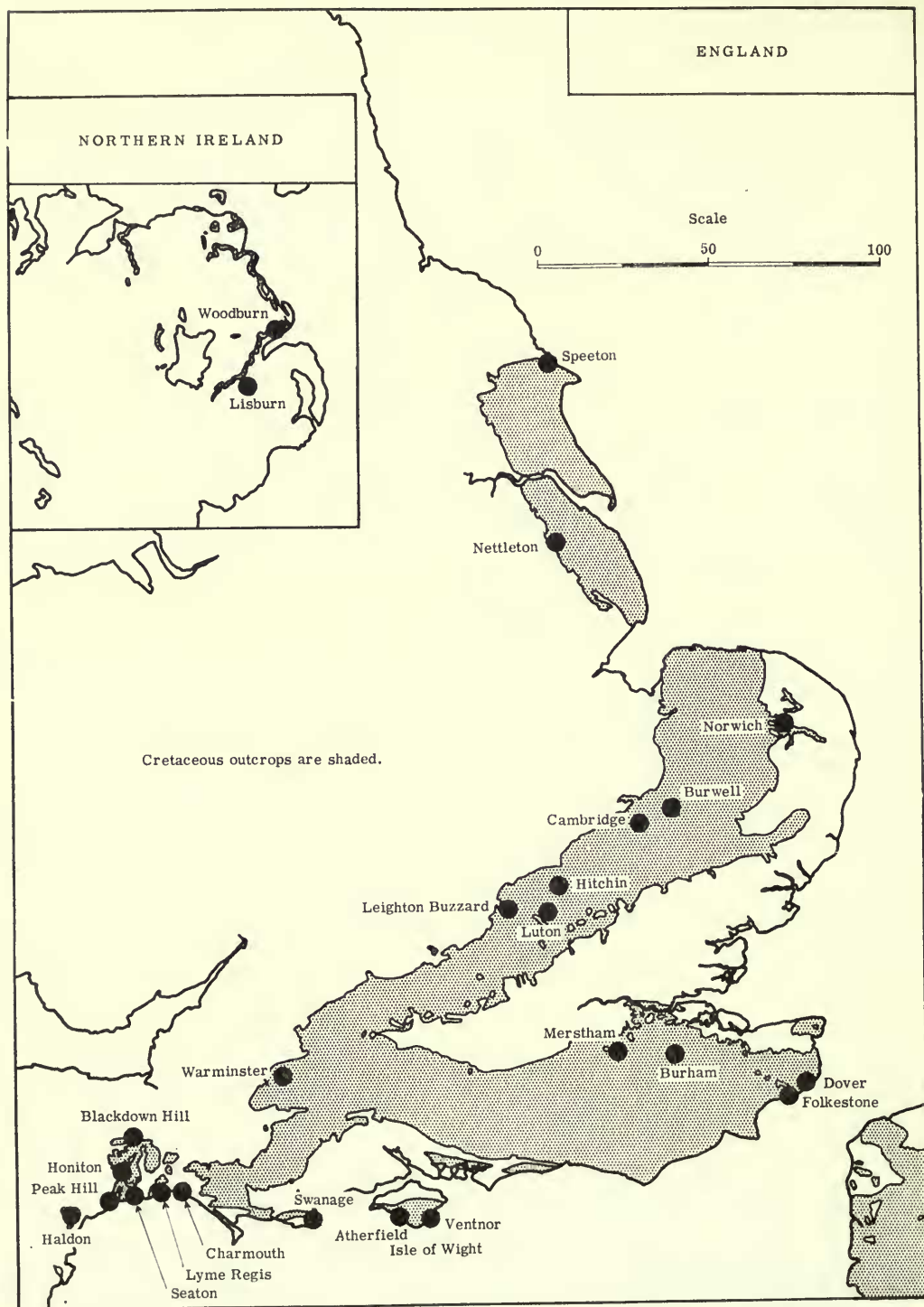


FIG. 1. Sketch map showing the Cretaceous outcrop in England and Northern Ireland, with localities marked.

representatives of the Turritellidae, and the contemporaneous Wealden deposits of south-eastern England are deltaic and lacustrine sediments with fossil gastropods belonging to non-marine genera.

Aptian deposition began in the English area with marine transgressions from the south and north. The isthmus separating the northern and southern basins was eventually submerged in mid-Aptian times, and throughout the rest of the Cretaceous period there was a single basin of deposition in the British area. The Aptian rocks or Lower Greensand of the Weald and other districts of the English mainland have not yielded any of the gastropods described in the present study, but the rich faunas found in the south of the Isle of Wight near Atherfield, where the Lower Greensand reaches its maximum thickness of 800 ft., include members of both the Turritellidae and the Mathildidae. The two species here described, *Turritella* (*Torquesia*) *tamra* sp. nov. and *Mathilda coxi* sp. nov., both come from the rock bands known as the Crackers, belonging to the Atherfield Clay series.

The Albian stage is represented in the Wealden district by the upper part of the Folkestone beds and by the Gault, a stiff clay, the narrow, elliptical outcrop of which occupies low-lying ground between the Lower Greensand hills and the Chalk downs. The thickness of the Gault is variable, being about 300 ft. near Eastbourne and 100 ft. at Folkestone, and at the latter locality its rich fauna includes many gastropods, most of which, however, are more or less crushed. Two species from the Gault of Folkestone, *Turritella* (*Torquesia*) *vibrayeana* d'Orbigny and *Turritella* (*Torquesia*) *wagihi* sp. nov., are described in the present paper, and the first has also been found in the thin deposit of Gault clay found below the Upper Greensand at Charmouth, Dorset. The Greensand of Blackdown, Devon, also of Albian age, is the most prolific source of Cretaceous gastropods in England, and they are silicified and relatively well preserved. The following species from Blackdown are here described: *Turritella* (*Torquesia*) *granulata* J. de C. Sowerby, *Turritella* (*Torquesia*) *faizai* sp. nov., *Turritella* (s. lat.) *ageri* sp. nov., *Turritella* (s. lat.) *sherborni* sp. nov., and *Mathilda ahmadi* sp. nov. The first occurs in great abundance.

The Cenomanian stage is represented by rocks of greensand facies in south-eastern Devon and in the Warminster district of Wiltshire. *Turritella* (*Torquesia*) *granulata* occurs in the Cenomanian of both areas, and a second species, *Turritella* (*Torquesia*) *hassani* sp. nov., in Devon. Except in these two areas, deposition of calcareous marl now represented by chalky rocks had begun by the beginning of Cenomanian times. This change in sedimentation was formerly interpreted as the result of a gradual sinking of the sea-floor that continued, with slight pauses, for a long period over almost the whole area that is now the British Isles. The lack of clastic sediment may, however, have been due to other causes, as the fossils found in the Chalk do not seem to have been deep-sea forms. The Cenomanian chalky rocks of Kent and Cambridgeshire have yielded *Turritella* (*Turritella*) *dibleyi* Newton, and those of Sussex and the Isle of Wight "*Turritella*" *turbinata* J. de C. Sowerby, a large gastropod which belongs most probably to a new genus.

Although rare in the great mass of the post-Cenomanian Chalk, gastropods are relatively abundant in the rock-bands at the top of the Turonian known at the Chalk Rock, but no Turritellidae have been found at this horizon. The Senonian

Chalk of Norwich, however, has yielded the species *Turritella* (*Turritella*) *unicarinata* (S. Woodward), a form also found in the Upper Chalk of northern Ireland.

TABLE I.—*Summary of the Distribution in England of the Species Described*

	Aptian	Albian	Cenoman.	Turon.	Senon.
<i>Turritella</i> (<i>Turritella</i>) <i>dibleyi</i>	.	.	Kent, Cambs.	.	.
„ „ <i>unicarinata</i>	.	.	.	.	Norfolk
„ (<i>Torquesia</i>) <i>granulata</i>	.	Devon	Devon, Wilts.	.	.
„ „ <i>tamra</i>	I. o. W.	.	.	.	.
„ „ <i>vibrayeana</i>	.	Kent, Dorset	.	.	.
„ „ <i>wagihi</i>	.	Kent	.	.	.
„ „ <i>faizai</i>	.	Devon	.	.	.
„ „ <i>hassani</i>	.	.	Devon	.	.
„ (s. lat.) <i>ageri</i>	.	Devon	.	.	.
„ „ <i>sherborni</i>	.	Devon	.	.	.
<i>Mathilda</i> <i>coxi</i>	I. o. W.	.	.	.	.
„ <i>ahmadi</i>	.	Devon	.	.	.
“ <i>Turritella</i> ” <i>turbinata</i>	.	.	Sussex, I. o. W.	.	.

NOTES ON TAXONOMY AND TERMINOLOGY

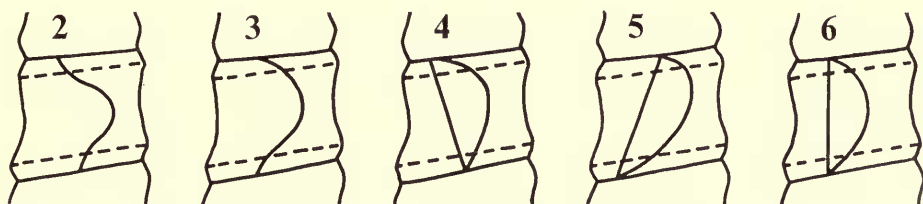
Of modern authors who have discussed the morphology of the shell in the Turritellidae and the taxonomic value of its various features, particular mention may be made of Cossmann (1906, 1912, 1916), Guillaume (1924), Dollfus (1926), Merriam (1941) and Marwick (1957). All of these workers have pointed out the significance of the form of the growth-lines as seen between successive sutures on the spire whorls, and Marwick has extended the study of the growth-lines to their continuation as seen on the base of the last whorl.

Cossmann, in his review of the family, also took into account the outline and ornament of the whorls and the degree of acuteness of the spire. He recognized three genera with numerous subgenera and sections, and he considered *Turritella* (*Turritella*), *Turritella* (*Zaria*), *Turritella* (*Haustator*), *Turritella* (*Peyrotia*), *Turritella* (*Archimediella*), and *Mesalia* all to be represented in the Cretaceous, *T.* (*Haustator*) by numerous species. The studies of Guillaume were confined to Tertiary forms. This author based his classification entirely on the form of the growth-lines as seen between the sutures, but he did not assign subgeneric names to the groups which he distinguished. Merriam, in his work on the Upper Cretaceous and Tertiary Turritellidae of western North America, paid attention, not only to the growth-lines, but also to the order in which the elements of spiral ornament appear in the early ontogeny of the shell. He recognized a number of distinct lineages but refrained from assigning subgeneric names to them.

Marwick, in his generic revision of the family, considers both the growth-lines and the ontogeny of the primary elements of spiral ornament to be valuable criteria for classification, and he also finds that the nature of the protoconch is of help in this connection. He interprets genera in a more restricted sense than did his pre-

decessors, recognizing 33 in all, distributed among five subfamilies; in addition, he regards nine named taxa as subgenera. The data assembled by Marwick show that the following genera or subgenera have species of Cretaceous age as their types: *Arcotia* Stoliczka (Upper Cretaceous, India), *Colposigma* Finlay & Marwick (Danian, New Zealand), *Craiginia* Stephenson (Cenomanian, North America), *Leptocolpus* Finlay & Marwick (Danian, New Zealand), *Sechuritella* Olsson (Upper Cretaceous, Peru), and *Torquesia* Douvillé (Cretaceous, widespread). The geological ranges of the various genera are not given in Marwick's paper and it is possible that he would consider some of those with Tertiary or Recent type-species to be represented in the Cretaceous.

Owing to the state of preservation of the available material it is seldom possible, when studying Cretaceous specimens, to observe the protoconch, the development of the elements of spiral ornament in early ontogeny, or even the growth-lines on the base of the last whorl. In the present paper, therefore, particular attention is paid



FIGS. 2-6. Terminology of growth-lines in Turritellidae.

2. Two points of inflection.
3. One point of inflection.
4. No point of inflection. Growth-line chord prosocline.
5. No point of inflection. Growth-line chord opisthocline.
6. No point of inflection. Growth-line chord orthocline.

to the form of the growth-lines between the sutures, and the taxonomic groups of Turritellidae which are recognized are treated as subgenera of *Turritella*. The forms described include the type-species of *Torquesia* (*Turritella granulata* J. de C. Sowerby), and this subgenus has proved to be suitable for the reception of several other English species. The other taxa mentioned above as being based on Cretaceous species are not represented in the material studied.

Two of the *Turritella*-like species here described have been recognized as representatives of the genus *Mathilda*, the presence of which in the Cretaceous was first recorded by Cossmann. One of these (*M. coxi* sp. nov.) is the earliest known representative of the genus and of the family Mathildidae.

The terminology employed in the present paper is mainly that used by previous students of the Turritellidae. The less familiar terms are explained by Text-figs. 2-6. The *growth-line chord* may be defined as a straight line joining the points where a growth-line meets successive sutures.

Most of the new species are named after geologists and others who have helped the author during the course of the work.

SYSTEMATIC DESCRIPTIONS

Class GASTROPODA

Subclass PROSOBRANCHIA

Superfamily CERITHIACEA Fleming, 1822

Family TURRITELLIDAE Woodward, 1851

Genus *TURRITELLA* Lamarck, 1799: 74TYPE SPECIES.—*Turbo terebra* Linnaeus, 1758 (by monotypy).Subgenus *TURRITELLA* s. str.

SUBGENERIC CHARACTERS.—Shell medium-sized to large, slender; whorls evenly convex, ornamented with spiral cords and threads; growth-lines between sutures forming a simple sinus of no great depth.

Turritella (Turritella) dibleyi Newton

(Pl. 29, figs. 7, 8; Text-fig. 7)

1918. *Turritella dibleyi* Newton, p. 97, pl. 10, figs. 1, 2.

HOLOTYPE.—In the British Museum (Natural History), reg. no. G. 29362.

DESCRIPTION.—The shell is moderately large and slender. The apical whorls, up to a diameter of about 9 mm., are missing in the holotype. The whorl outline is rather strongly convex, but in the holotype the convexity of the earlier preserved whorls has apparently been reduced by pressure; the suture is moderately deep. About 30 spiral threads are present on the spire whorls. They are crossed by collabral threads which tend to become prominent at variable intervals, almost forming varices, and become generally stronger on the later whorls, so that the appearance of collabral ornament is developed in places. The spiral threads are separated by interspaces the width of which is almost equal to that of the threads. The base and aperture are damaged in the holotype. The growth-lines show a broad, shallow sinus with no points of inflection, and the growth-line chord is prosocline (Text-fig. 7).

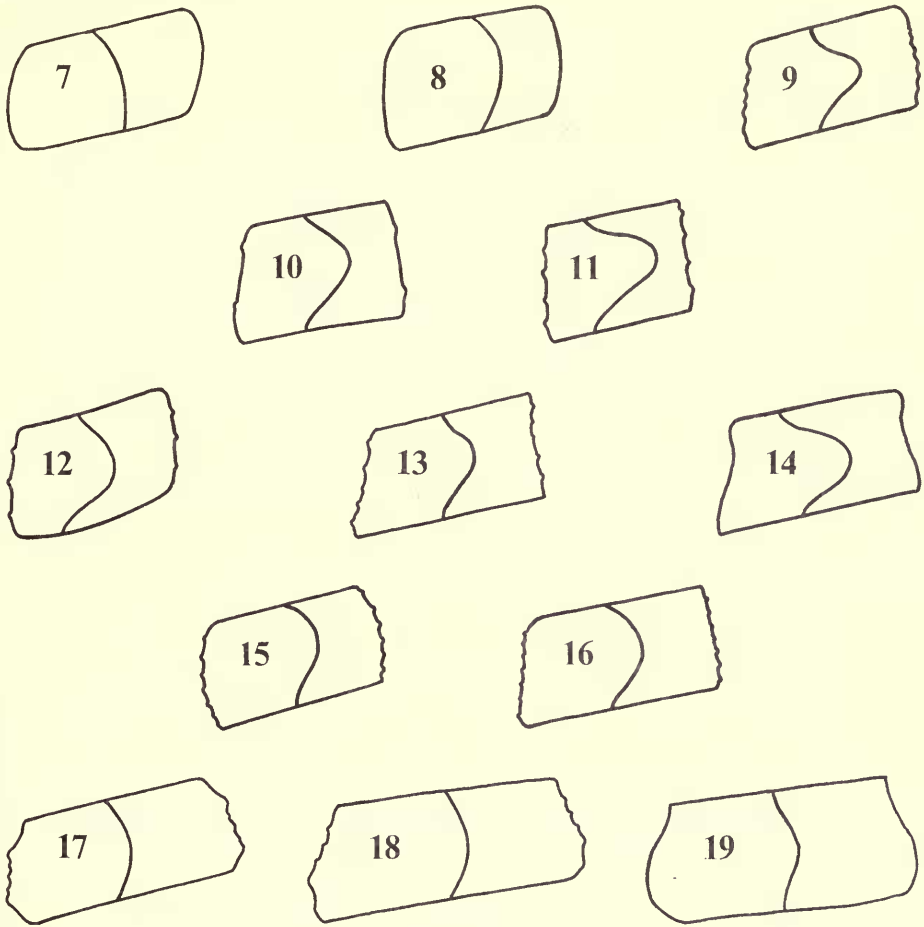
Measurements of the Holotype:

Height (as now preserved)	.	.	.	75 mm.
Spire angle	.	.	.	13°
Height of penultimate whorl	.	.	.	12 mm.
Diameter of penultimate whorl	.	.	.	19 mm.

DISCUSSION.—This species is included in the subgenus *Turritella* s. str. as its growth-lines have a simple, shallow sinus and a strong prosocline trend, as in the type-species of the genus. It differs from *T. (T.) unicarinata*, described below, in the presence of a greater number of spirals and of frequent collabral rugae.

OCCURRENCE. The holotype came from the Chalk Marl (Cenomanian) of Margett's Pit, Burham, Kent. The species has also been reported from the same formation at

Folkestone and from the Burwell Rock (Cenomanian) at Burwell and Reach, in Cambridgeshire.



FIGS. 7-19. Diagrams of growth-lines of the species described in this paper.

7. *Turritella* (*Turritella*) *dibleyi* Newton.
8. *Turritella* (*Turritella*) *unicarinata* (S. Woodward).
9. *Turritella* (*Torquesia*) *granulata* J. de C. Sowerby.
10. *Turritella* (*Torquesia*) *tamra* sp. nov.
11. *Turritella* (*Torquesia*) *vibrayeana* d'Orbigny.
12. *Turritella* (*Torquesia*) *wagihi* sp. nov.
13. *Turritella* (*Torquesia*) *faizai* sp. nov.
14. *Turritella* (*Torquesia*) *hassani* sp. nov.
15. *Turritella* *ageri* sp. nov.
16. *Turritella* *sherborni* sp. nov.
17. *Mathilda* *coxi* sp. nov.
18. *Mathilda* *ahmadi* sp. nov.
19. "*Turritella*" *turbinata* J. de C. Sowerby.

Turritella (Turritella) unicarinata (S. Woodward)

(Pl. 28, figs. 3-5 ; Text-fig. 8)

1833. *Cerithium unicarinatum* S. Woodward, p. 49, pl. 6, fig. 21.
 1854. *Nerinaea unicarinata* (Woodward) : Morris, p. 264.
 1865. *Turritella unicarinata* (Woodward) : Tate, p. 37, pl. 3, fig. 7.

HOLOTYPE. Not traced.

DESCRIPTION. The shell is moderately large and slender. The earlier whorls, up to a diameter of 8 mm., are missing in the specimens studied. The whorls which are preserved are feebly and almost symmetrically convex in outline and the suture is moderately deep. The later whorls bear about 30 very finely beaded spiral threads, separated by equal interspaces nearly equal in width to the threads, but becoming slightly wider than them towards the anterior suture. Each interspace is usually occupied by one secondary spiral. The base is slightly convex and has an angular periphery. It is crossed by spirals of the same nature as those on the whorl-side. The growth-lines have a broad sinus without points of inflection and the growth-line chord is orthocline (Text-fig. 8). A furrow on the internal mould appears to be the impression of a depressed median spiral fold on the interior of the whorls. The aperture is subquadrate.

Measurements of a Typical Specimen (G.S.M. no. 28256) :

Height (as now preserved)	.	.	.	.	.	51 mm.
Spire angle	.	.	.	.	.	13°
Height of penultimate whorl	.	.	.	.	.	12 mm.
Diameter of penultimate whorl	.	.	.	.	.	16.5 mm.

DISCUSSION. This species has been referred to such different genera as *Cerithium*, *Nerinea* and *Turritella*. The absence of an anterior canal or notch excludes it from the first two genera and it also differs from *Nerinea* in the absence of internal folds (apart from the single one mentioned) and of a juxta-sutural sinus band. The entire aperture and other characters show that it belongs to *Turritella*, and it is included in *Turritella* s. str. on account of the simple arcuate form of its growth lines.

OCCURRENCE. The holotype was found in the Upper Chalk of Norwich, where internal moulds are frequent. The species also occurs in the Upper Chalk of Northern Ireland, where it is common in the White Limestone (Campanian) at Lisburn and rare in the Spongarian Zone (Santonian) at Woodburn.

Subgenus **TORQUESIA** Douvillé, 1929 : 55

TYPE SPECIES. *Turritella granulata* J. de C. Sowerby (designated by International Commission on Zoological Nomenclature, Opinion 493, 1957).

SUBGENERIC CHARACTERS. Shell medium-sized, more or less slender ; whorls flat to moderately convex, ornamented with beaded spiral cords ; growth-lines forming

a rather deep sinus with its vertex nearly at mid-whorl and with points of inflection above and below it ; growth-line chord orthocline to feebly prosocline.

Turritella (Torquesia) granulata J. de C. Sowerby

(Pl. 30, figs. 10-14 ; Text-fig. 9)

1811. *Cerithium turritellatum* Parkinson, p. 71 (*non* Lamarck).
 1816. *Turritella* sp. : Smith, p. 12, " Green Sand " pl., fig. 5.
 1827. *Turritella granulata* J. de C. Sowerby, p. 125, pl. 565, fig. 1.
 1840. *Turritella granulata* Sowerby : Geinitz, p. 44, pl. 15, figs. 7-11.
 1842. *Turritella granulata* Sowerby : d'Orbigny, p. 46, pl. 153, figs. 5-7.
 1843. *Turritella granulata* Sowerby : Geinitz, p. 10, pl. 1, fig. 18.
 1845. *Turritella granulata* Sowerby : Geinitz, p. 325, pl. 14, figs. 9, 10.
 1849. *Turritella granulata* Sowerby : Brown, p. 70, pl. 38, fig. 18.
 1850. *Turritella granulatoidea* d'Orbigny, p. 190.
 1868. *Turritella granulata* Sowerby : Briart & Cornet, p. 29, pl. 3, figs. 43, 44.
 1875. *Turritella granulata* Sowerby : Geinitz, p. 239, pl. 54, figs. 3, 4.
 1920. *Turritella (Haustator) granulata* Sowerby : Roman & Mazeran, p. 44, pl. 5, fig. 21.
 1920. *Turritella (Haustator) granulatoidea* d'Orbigny : Roman & Mazeran, p. 44, pl. 5, figs. 17-20.

HOLOTYPE. In the British Museum (Natural History), reg. no. 43667.

DESCRIPTION. The shell is of medium size and moderately slender. The protoconch is not preserved in an uneroded state in the specimens studied. The whorl outline is feebly convex and the whorls are relatively high. The suture is at first superficial but becomes progressively more furrowed between the later whorls, which tend to become disjunct in some specimens. On the earliest whorls of which the ornament has been observed four beaded spiral cords are present in all variations of this species, and their interspaces soon become occupied by one or more spiral threads which are finely beaded. Some of these spiral threads increase in prominence during growth so that on the later whorls they become as strong as the primary cords, and, as a result, there may be as many as 7-8 principal spirals on the last whorl. The most posterior spiral cord is stronger than the others and is separated from them by a relatively broad spiral groove ; this feature is diagnostic of the species. On the later whorls, especially the last, the beads on the cords are located along conspicuous growth-lines, and those on the most posterior cord produce a feeble undulation of the suture. The base is convex and is ornamented with spiral cords crossed by growth-rugae. The aperture is oval, with a rounded anterior margin. The thin inner lip is reflected on the columella. The growth-lines have a deep U-shaped sinus and two points of inflection, one near each suture ; the growth-line chord is slightly prosocline (Text-fig. 9).

Measurements of Holotype :

Height	.	.	.	.	.	.	46 mm.
Spire angle	.	.	.	.	.	.	18°
Height of penultimate whorl	.	.	.	.	.	.	8 mm.
Diameter of penultimate whorl	.	.	.	.	.	.	10 mm.

VARIABILITY. This species is rather variable. One variant is similar to the

holotype except that its ornament consists even on the later whorls of only four principal cords with very conspicuous beads. It would appear that additional shelly matter was added during growth to the primary spirals instead of to secondary spirals in their interspaces. (See Pl. 30, fig. 14.)

DISCUSSION. The specimens figured by d'Orbigny (1842) as *T. granulata* had five spiral cords (not four, as stated by Roman & Mazeran, 1920), and subsequently d'Orbigny considered them to belong to a different species, *T. granulatoïdes*, distinguished from the true *T. granulata* by the smaller number of its spiral cords and by the deeper sinus of its growth-lines. The present writer has found that specimens agreeing with both forms occur in association at Blackdown, while Roman & Mazeran mention that they are found together in the Turonian of the Uchaux Basin (France). It thus seems reasonable to re-unite them as one species.

Cossmann (1912) referred *T. granulata* to Montfort's subgenus *Haustator* (type-species *Turritella imbricata* Lamarck, Eocene). He included in this subgenus a great number of turritellids with growth-lines of the same type as those of the type-species, namely, with a deep sinus near the middle of the whorl and points of inflection above and below it. He admitted, however, that forms differing considerably from the type-species in whorl outline and ornament were thereby brought together. Roman & Mazeran (1920) also referred *T. granulata* to *Haustator*. Douvillé (1929), however, was of the opinion that Cossmann had interpreted *Haustator* too widely and considered that the group of Cretaceous species with rather similar growth-lines but commonly with a beaded cord near the posterior suture should constitute a new subgenus *Torquesia*. He cited as type-species of this new taxon "*T. granulosa* de Blackdown", which the International Commission on Zoological Nomenclature, following a petition by Dr. J. Marwick, has decided was an unintentional error for *Turritella granulata*. Marwick (1957: 160) rather doubts the taxonomic importance of beaded spiral cords, but nevertheless considers that *Torquesia* is a taxon in which many Cretaceous species may usefully be included. The growth-lines are more symmetrical and the upper point of inflection is more marked than in the type-species of *Haustator* as figured by Marwick (1957: 146, text-fig. 14), and their general trend is less pronouncedly prosocline. *Torquesia* is, therefore, here accepted as a subgenus in which several English Cretaceous species can be included.

OCCURRENCE. *T. granulata* is very abundant in the Albian Greensand of its type-locality, Blackdown, Devon, although specimens retaining the initial whorls and showing the whole ornament clearly are very rare. Specimens from the Cenomanian of Warminster, Wilts., and of Devon (*falcatus* Zone) have also been examined. A queried record of the occurrence of the species in the Lower Greensand of Ingoldsthorpe, Norfolk (Forbes, 1845) is to be rejected.

T. granulata has been recorded from the Cenomanian of various parts of the European Continent, including the Elbe valley district of Saxony, where it occurs in both the Lower Quadersandstein and the Lower Pläner (Geinitz, 1874), Bohemia (Reuss, 1845), Bavaria (Söhle, 1896), the Baltic coastlands in glacial erratics (Noetling, 1885), and Belgium, where it occurs in the so-called *meule de Bracquegnies*. D'Orbigny (1842) and Roman & Mazeran (1920) have recorded it from the Turonian of Uchaux in France.

Turritella (Torquesia) tamra sp. nov.

(Pl. 28, fig. 1; Text-fig. 10)

HOLOTYPE. In the Sedgwick Museum (Cambridge), reg. no. B. 27329.

DESCRIPTION. The shell is small and slender. The actual protoconch is not preserved in the specimens studied and the earlier whorls are worn. The whorls are moderately high, with a slightly convex outline, and they are separated by a well-impressed suture. Four beaded primary cords are present when the whorl diameter is 2 mm. and on the later whorls the number of principal spirals has increased to about six, one of which is close to the anterior suture. These are separated by considerably wider interspaces occupied by from one to three spiral threads, some not very much weaker than the principal spirals. The beads on the spirals are weak and some are elongated in a spiral direction with the spaces between them varying in width. The base is convex and is bordered by the primary spiral which is seen just above the suture on the later spire whorls; below this are three more primaries, decreasing in strength inwards, with fine secondary threads between them. The aperture is not preserved. The growth-lines have a deep sinus the vertex of which lies between the second and the third primary cord from the posterior suture, that is, well above the middle of the whorl; there are two points of inflection. The growth-line chord is very slightly opisthocline (Text-fig. 10).

Measurements of the Holotype:

Height	.	.	.	.	.	.	26 mm.
Spire angle	.	.	.	.	.	.	14°
Height of penultimate whorl	.	.	.	.	.	.	3.5 mm.
Diameter of penultimate whorl	.	.	.	.	.	.	5 mm.

DISCUSSION. Several other specimens of this species are preserved in the small piece of rock which contains the holotype, but only two (including one which has been registered separately as B. 27330) show any diagnostic characters.

This species is included in the subgenus *Torquesia* because of its growth-line pattern and of its ornament, which bears a general resemblance to that of *T. granulata*. It differs from that species, of which it is possibly the ancestor, in its smaller size, more convex whorl outline, weaker spirals, and fewer and weaker beads.

OCCURRENCE. Aptian, Lower Greensand, Atherfield Clay Series (bed known as the "Crackers"), Atherfield, Isle of Wight.

Turritella (Torquesia) vibrayeana d'Orbigny

(Pl. 31, figs. 17-22; Text-fig. 11)

1842. *Turritella vibrayeana* d'Orbigny, p. 37, pl. 151, figs. 10-12.
 1860. *Turritella vibrayeana* d'Orbigny: Mackie, p. 324, fig. 34.
 1862. *Turritella vibrayeana* d'Orbigny: Pictet & Campiche, p. 315, pl. 72, figs. 5-7.
 1896. *Turritella vibrayeana* d'Orbigny: Cossmann, p. 255, pl. 1, figs. 24-26.
 1903. *Turritella vibrayeana* d'Orbigny: Doncieux, p. 301, pl. 1, fig. 1.
 1954. *Turritella* cf. *vibrayeana* d'Orbigny: Gortani, p. 75, pl. 16, figs. 2a, b.

SYNTYPES. Nine specimens in the d'Orbigny Collection in the Muséum National d'Histoire Naturelle, Paris, reg. no. 5847.

DESCRIPTION. The shell is of small to medium size and very slender, with relatively high whorls. The whorl sides are usually flat but may be feebly convex; the suture is superficial or slightly furrowed. The initial whorls have a tricostate ornament. The three primary spiral cords may persist on the later whorls without the addition of other strong spirals (Pl. 31, fig. 19), but usually a fourth principal cord is added near the posterior suture (Pl. 31, fig. 20), while a fifth may appear in the most posterior interspace (Pl. 31, fig. 18) and a sixth in the most anterior interspace (Pl. 31, fig. 22). The spiral cords are beaded, some rather coarsely, others faintly. Some of the interspaces are almost equal to the primary cords in width, but most of them are wider, sometimes as much as five to six times as wide (Pl. 31, fig. 17). Secondary threads, variable in number, occupy these interspaces, and usually one or two are more prominent than the rest. The base is slightly convex, with spiral cords and threads crossed by growth-lines. The aperture is oval and evenly rounded anteriorly. The growth-lines are of about the same strength as the secondary spiral threads. They show a deep sinus with its vertex near the middle of the whorl and two points of inflection, one near each suture. The growth-line chord is almost orthocline (Text-fig. 11).

Measurements of a Typical Specimen (B.M., no. G.73791):

Height	40 mm.
Spire angle	10°
Height of penultimate whorl	3.5 mm.
Diameter of penultimate whorl	6 mm.

DISCUSSION. *Turritella vibrayeana* has been described by previous authors as having four primary beaded spiral cords alternating with secondary ones. Actually, it is a highly variable species. At one extreme of the range of variation are forms retaining on the later whorls the same number of primary spiral cords as are found on the initial ones, and at the other extreme are specimens in which as many as three additional principal cords have been added. There appears to be no justification for separating shells with additional spiral cords on the later whorls as distinct species or subspecies, since all specimens show the same growth-line pattern and the ornament of the initial whorls is always tricostate. The variation in the number of principal cords may be due to unimportant environmental or physiological factors, although its causes may be merely genetic.

The first reference in the literature to specimens belonging to this species was when Michelin (1838: 99) referred a *Turritella* from the Gault of the Aube Department of France to *Turritella rigida* J. de C. Sowerby (1833, pl. 38, fig. 19), a species from Gosau, in Austria. *T. rigida* has a prominent posterior tuberculate spiral cord on which the tubercles are markedly elongated and extend to the suture, and this feature is not found in specimens from the Gault. In view of these differences d'Orbigny (1842) erected his new species *T. vibrayeana* for the latter. The figures of Pictet & Campiche, illustrating specimens from Switzerland, agree with our description.

Doncieux (1903), when recording specimens from the Gault of the eastern Corbières, in the south of France, stated that they differed from the holotype of d'Orbigny in

the inequality of the spiral cords (the most anterior of these being the strongest) and also of the secondary spirals. His figures, however, do not show these features. Cossmann (1912) included *T. vibrayeana* in the subgenus *Haustator*. The present writer agrees that relationship with *Turritella granulata* is indicated by the growth-line pattern and by the general character of the ornament. *T. vibrayeana* is, therefore, now included in the subgenus *Torquesia*. Merriam (1941), in discussing his "first stock" of *T. tolenasensis* Merriam, referred to *T. vibrayeana* as showing similarities to some American species.

OCCURRENCE. All the specimens examined in the preparation of this paper are from the Gault of Folkestone, Kent, except one (G.49825) which was collected by Dr. W. D. Lang from the Lower Gault of Fairy Dell, Stonebarrow, Charmouth, Dorset. *T. vibrayeana* has been found in the Albion of France at several localities in the Aube Department and the eastern Corbières, and it has also been recorded from Switzerland, Italy and Russia.

Turritella (Torquesia) wagihi, sp. nov.

(Pl. 29, fig. 6 ; Text-fig. 12)

HOLOTYPE. In the Geological Survey Museum, reg. no. 93745.

DESCRIPTION. The shell is of medium size and moderately slender. The whorls are feebly convex, with a weak carina close to the anterior suture, giving them a sub-imbricate appearance. The protoconch is not preserved. The earliest whorls seen are tricostate, with primary cords lying at the anterior quarter, the middle, and the posterior quarter respectively. The number of principal spiral cords remains the same on the later whorls, but they have moved a little further forward so that the space behind the most posterior cord is greater than that in front of the most anterior one. These spirals show a marked difference in strength and in the number of beads on them. Thus, while the beads are relatively strong and wide apart on the most posterior cord, those on the most anterior one are more numerous, closer, and weaker. The primary interspaces are three to four times as wide as the primary spiral cords, and each is occupied by two secondary spiral cords and four or five spiral threads. The aperture and base are not preserved in the holotype. The growth-lines have a broad and rather shallow sinus with its vertex at about the middle of the whorl and two points of inflection ; the growth-line chord is slightly opisthocline (Text-fig. 12).

Measurements of the Holotype :

Height	.	.	.	.	.	49 mm.
Spire angle	.	.	.	.	.	14°
Height of penultimate whorl	.	.	.	.	.	5 mm.
Diameter of penultimate whorl	.	.	.	.	.	10 mm.

DISCUSSION. The holotype, the only specimen seen, is crushed and its spire angle may be greater than was originally the case. This species bears some resemblance to *Turritella vibrayeana* and its variations, but can be distinguished by the shape of the shell, the lower whorls, the more convex whorl outline, the peculiar difference

in the granulation of the primary spiral cords and the development of the spiral ornament during the ontogeny of the shell. It differs from *T. marticensis* Matheron (1843: 240, pl. 39, fig. 16) in the presence of the anterior carination and in the nature of the ornament. The growth-lines are not indicated clearly enough in Matheron's figure to allow comparison to be made with those of the present species.

OCCURRENCE. Albion, Gault, Folkestone, Kent.

Turritella (Torquesia) faizai sp. nov.

(Pl. 30, fig. 15; Text-fig. 13)

HOLOTYPE. In the Sedgwick Museum (Cambridge), reg. no. B.44621.

DESCRIPTION. The shell is of medium size and moderately slender. The earlier whorls have a slightly convex outline with a feeble anterior carination, but the later whorls become concave mesially, with anterior and posterior convexities. The suture is moderately deep. The protoconch is broken off in the holotype. The earliest preserved whorls are tricostate, the most anterior spiral cord coinciding with the carination. On later whorls a secondary spiral cord is developed behind each primary spiral, and these secondaries increase in strength rapidly until they become as strong as the primaries, so that the total number of principal spiral cords is increased to six. The cords are finely beaded and are separated by wider interspaces most of which are occupied by one secondary and two tertiary threads. The most anterior primary cord is separated from the adjacent suture by an interspace wider than that between the posterior primary and the corresponding suture. A secondary spiral which develops in this latter interspace becomes as strong as the most posterior primary on the later whorls and fuses with it to form a strong astragal¹ which affects the whorl outline. The base is almost flat, with a rounded edge, and bears concentric cords which alternate in strength. The aperture is broken away but was evidently subquadrangular. The growth-lines have a deep, broad sinus and points of inflection coinciding with the anterior and posterior convexities. The growth-line chord is almost orthocline (Text-fig. 13).

Measurements of the Holotype:

Height	.	.	.	.	.	.	53 mm.
Spire angle	.	.	.	.	.	.	16°
Height of penultimate whorl	.	.	.	.	.	.	8 mm.
Diameter of penultimate whorl	.	.	.	.	.	.	15 mm.

DISCUSSION. This species is distinguished from *Turritella (Torquesia) hassani*, described below, by the relative weakness of the astragal on the posterior part of the whorls and by the anterior convexity of the whorls. It also has fewer secondary threads between the principal spiral cords.

OCCURRENCE. Albion of Devon; the holotype came from the Greensand of Blackdown and specimens have also been found in the Upper Greensand of Peak Hill (west of Sidmouth), Seaton and Beer.

¹ Astragal.—A moderately broad, parallel-sided elevation with a rounded profile (architectural term).

Turritella (Torquesia) hassani sp. nov.

(Pl. 28, fig. 2 ; Pl. 29, fig. 9 ; Text-fig. 14)

HOLOTYPE. In the British Museum (Natural History), reg. no. G.49907.

DESCRIPTION. The shell, not known complete, is of medium size, slender, and nerineiform. The whorl outline is flat or slightly concave and the sutures are superficial. A rounded posterior astragal, occupying about one-fifth of the height of the whorl, is developed just below the suture. Eight or nine very faintly beaded primary spiral cords are distributed equally over the anterior four-fifths of the whorl ; the interspaces are two to three times as wide as the cords. These interspaces are occupied by four to seven fine spiral threads of which the middle one is sometimes stronger than the others ; similar spiral threads cover the rounded posterior astragal. The base and aperture are not preserved in the available specimens. The growth-lines have a deep sinus with its vertex at the middle of the whorl and two points of inflection. The growth-line chord is slightly prosocline (Text-fig. 14).

Measurements of the Holotype :

Height (four mid-spire whorls)	.	.	.	40.5 mm.
Spire angle	.	.	.	$42\frac{1}{2}^{\circ}$
Height of last preserved whorl	.	.	.	9 mm.
Diameter of last preserved whorl	.	.	.	14 mm.

DISCUSSION. This species is founded on three imperfect specimens now in the British Museum (Natural History), two collected by Mr. T. F. Grimsdale, the third by Mr. C. W. Wright. It differs from the other turritellids described in this work in having concave whorls with a rounded posterior astragal crossed by spiral threads and in other details of ornament. The growth-line pattern is similar to that of *Turritella (Torquesia) granulata* J. de C. Sowerby, and this permits its inclusion in the same subgenus as that species.

OCCURRENCE. Cenomanian Limestone (Bed B of Jukes-Browne), "near Seaton, Devon" (type-locality). Same bed, between Havencliff and Dowlands, east of Seaton, Devon (*ex* C. W. Wright Collection).

Subgenus novum ?

In the two species described next the growth-lines have a broad sinus with its vertex at about mid-whorl and an inflection point close to the lower suture ; the growth-line chord is almost orthocline. The whorls are feebly convex and the ornament is of beaded spiral cords. Of the turritellid growth-lines figured by Marwick (1957 : 146), those of *Pareora* (fig. 25) are most like those of the two new species, but the sinus is deeper and its vertex is higher on the whorl. In *Sigmesalia* (Marwick's fig. 31) the growth-lines rather resemble those of these species, but the point of inflection coincides with the lower suture. In other characters there is little resemblance between the forms now described and either *Pareora* or *Sigmesalia*. It is probable that they belong to a new subgenus, but since neither their apertures

nor their initial whorls can be studied this could not at present be defined satisfactorily.

Turritella ageri sp. nov.

(Pl. 32, fig. 25 ; Text-fig. 15)

HOLOTYPE. In the British Museum (Natural History), reg. no. G.74106.

DESCRIPTION. The shell is moderately slender and of medium size. The whorl outline is feebly and symmetrically convex, the suture very slightly impressed. The initial whorls, up to a diameter of 3 mm., are not preserved in the specimens studied. The whorls now preserved have 6–8 coarsely beaded spiral cords which increase in strength during growth. On the last whorl the width of the interspaces is equal to or slightly exceeds that of the cords. Each interspace is occupied by three or four spiral threads, the middle one of which may be more prominent than the others and ultimately become as strong as the primary cords. The beads are coarse, more or less rounded, and closely spaced. The base is slightly convex, with a rounded periphery, and is crossed by a number of spiral threads alternating in strength. The aperture is not complete in the holotype, but it can be inferred from the outline of the last whorl that it was more or less elliptical. The inner lip is reflected over the short and thick columella. The growth-lines have a broad, moderately deep sinus, the vertex of which lies on the third spiral cord from the posterior suture, that is, at about the posterior two-fifths of the height of the whorl. They straighten out to a point of inflection on the most anterior spiral cord. The growth-line chord is almost orthocline (Text-fig. 15).

Measurements of the Holotype:

Height	.	.	.	.	.	.	47 mm.
Spire angle	.	.	.	.	.	.	16°
Height of penultimate whorl	.	.	.	.	.	.	8 mm.
Diameter of penultimate whorl	.	.	.	.	.	.	14 mm.

DISCUSSION. This new species can be easily distinguished from similar forms, such as *Turritella* (*Torquesia*) *granulata* J. de C. Sowerby, by the absence of a very strong posterior spiral cord, by the prominence of the spirals on the last whorl, by its very coarse and rounded beads, and by the growth-line pattern.

OCCURRENCE. Albanian, Greensand, Blackdown, Devon.

Turritella sherborni sp. nov.

(Pl. 30, fig. 16 ; Text-fig. 16)

HOLOTYPE. In the British Museum (Natural History), reg. no. G.74107.

DESCRIPTION. The shell is of medium size, with whorls which are subimbricate owing to the presence of a weak carina which coincides with the second spiral cord from the anterior suture ; above this carina the whorl surface is almost flat. The sutures are slightly impressed. The initial whorls, up to a diameter of 4 mm., are not preserved in the holotype. On the whorls which are still seen there are seven

equal spiral cords ornamented with small, spirally elongated beads separated by constrictions which are nearly equal in width to the beads. The interspaces between the spiral cords are nearly double the width of the latter and are occupied by spiral threads, one or two of which may be stronger than the rest. The spiral threads show faint constrictions corresponding to those of the primary spiral cords. The base is rather obscured by adherent matrix in the holotype, but has a rounded periphery below which its surface is slightly convex. The aperture has an evenly rounded anterior margin and its height is about equal to its width. The growth-lines have a broad and moderately deep sinus the vertex of which lies just above the middle of the height of the whorl. They straighten out to a point of inflection just above the lower suture. The growth-line chord is almost orthocline (Text-fig. 16).

Measurements of the Holotype :

Height		30 mm.
Spire angle		16°
Height of penultimate whorl		6 mm.
Diameter of penultimate whorl		10 mm.

DISCUSSION. This new species much resembles *Turritella* (*Torquesia*) *granulata* J. de C. Sowerby, but differs in the equality of its spiral cords, in the presence of the anterior carination, and in the nature of the growth-lines. It shows a great similarity to *T. cenomanensis* d'Orbigny, as figured by Guéranger (1867, pl. 9, figs. 10, 11), but differs in having anteriorly carinate whorls, and probably also in the nature of the spiral cords, which are not clearly shown in Guéranger's figures. D'Orbigny (1850, p. 148) referred *T. granulata* Geinitz (1840, pl. 15, figs. 7-11, *non* Sowerby) to *T. cenomanensis*, but Geinitz (1874: 161) later included pl. 15, fig. 9 in the synonymy of *T. multistriata* Reuss. *T. cenomanensis* was included by Cossmann in the subgenus *Haustator*, but its growth-lines are unlike those of the type-species of that subgenus.

The new species *T. sherborni* differs from *T. ageri*, described above, in its anterior carination and finer granulation.

OCCURRENCE. Albion, Greensand, Blackdown, Devon.

Family MATHILDIDAE Cossmann, 1912

Genus **MATHILDA** Semper, 1865: 330

TYPE SPECIES. *Turbo quadricarinatus* Brocchi, 1814 (by subsequent designation, de Boury, 1883).

Mathilda coxi sp. nov.

(Pl. 32, fig. 23; Text-fig. 17)

HOLOTYPE. In the Sedgwick Museum (Cambridge), reg. no. B.27336.

DESCRIPTION. The shell is of small-medium size and broadly turriculate. Details of the protoconch have been a little obscured by erosion. Although not conspic-

uously heterostrophic, it exhibits a distinct discontinuity of coiling; its first complete whorl is an open one with a gap in the middle, and the actual nucleus seems to be partly obscured by this whorl. The first two visible whorls are smooth and rounded in outline, while the third develops a median carina. On the next succeeding whorls a second carina makes its appearance just in front of the posterior suture, but the original carina remains the more prominent. The concavity between these carinae, which come respectively to occupy positions at about the lower third and slightly above the upper third of the whorl, is reduced on the later whorls, which are biangular with an almost flat outer face. The suture is deep. The outer face of the later whorls is occupied by two to three spiral cords of primary strength, separated by interspaces which are of the same width or slightly narrower. Each interspace is occupied by one or by two secondary spirals. The area between each carina and the adjacent suture is similarly ornamented, but the spirals on the anterior area are the most prominent. On the last whorl two additional spiral cords of primary strength and below them a third carina become visible just above the suture. The periphery of the convex base is formed by a spiral keel continuing this third carina; below it is a further carina, and the remainder of the base bears concentric threads of two orders of strength. Where uneroded, the whole surface of the shell bears a delicate ornament of closely and regularly spaced collabral threads. The aperture is oval, with the inner lip slightly reflected. The growth-lines between the sutures form a broad arch, the chord of which is almost orthocone (Text-fig. 17).

Measurements of the Holotype:

Height	.	.	.	.	.	.	21 mm.
Spire angle	.	.	.	.	.	.	30°
Height of penultimate whorl	.	.	.	.	.	.	5 mm.
Diameter of penultimate whorl	.	.	.	.	.	.	10 mm.

DISCUSSION. The protoconch of the holotype of this species is not so obviously heterostrophic as in some of the figures of Tertiary species of *Mathilda* published by Semper (1865) and de Boury (1883), showing specimens in which the axis of coiling of the initial whorls is at right angles to that of the shell axis. In a specimen from the Miocene of southern France in the Wrigley Collection in the British Museum (Natural History), identified as belonging to the var. *semperi* Tournouer of the type-species of the genus, *M. quadricarinata* (Brocchi), the protoconch is, however, very similar to that of the species now described, and in some of the Paris Basin Eocene shells figured by de Boury (1883, pl. 5, figs. 7a, 9a, 10a, 11a) it also seems to be of a comparable type. In its general form and ornament as well as in its broadly arched growth-lines the present shell seems to be a typical *Mathilda*.

Cossmann (1912:10) recognizes two Cretaceous representatives of the genus, *M. douvillei* Cossmann (1912, pl. 1, figs. 3-5) and *M. faucignyana* (Pictet & Roux) (1849:166, pl. 16, fig. 1, *sub Turritella*), both Albian in age. *M. douvillei* is of about the same size and proportions as the new species *M. coxi*, but its ornament, although of the same general character, differs in detail.

OCCURRENCE. Aptian, Lower Greensand, Atherfield Clay Series (bed known as the "Crackers"), near Atherfield, Isle of Wight.

Mathilda ahmadi sp. nov.

(Pl. 32, fig. 24 ; Text-fig. 18)

HOLOTYPE. In the Sedgwick Museum (Cambridge), reg. no. B.44649.

DESCRIPTION. The shell is of small-medium size, turriculate, and moderately broad-spired. The protoconch is missing in the specimens studied, the earliest preserved whorl being about 1.5 mm. in diameter. All the whorls now present are bicarinate anteriorly, the posterior carina being slightly the more prominent and placed well below their median line. The interspace between the carinae is narrower than the latter and is occupied on the later whorls by one or two secondary spirals. The part of the whorl posterior to the carinae is occupied by two to five primary spirals which decrease in strength posteriorly and are separated by interspaces the width of which is about the same as that of the spirals or slightly greater ; each interspace is occupied by one secondary spiral. On the later whorls the more posterior of the main carinae carries spiral threads or (in one specimen) splits up into two cords. The narrow area anterior to the carinae is occupied by two or more secondary spirals, and a further carina becomes visible on the last whorl, continuing the line of the suture. Everywhere very fine and numerous, regularly spaced collabral threads form a cancellate ornament with the spirals. The base is convex and the spiral cord which forms its periphery is succeeded inwards by a number of weaker spirals, alternating in strength. The aperture is rounded and the inner lip thin and reflected. The growth-lines form a broad, shallow arch with its vertex at about the middle of the whorl ; the growth-line chord is almost orthocline (Text-fig. 18).

Measurements of the Holotype :

Height	.	.	.	.	.	22 mm.
Spire angle	.	.	.	.	.	18°
Height of penultimate whorl	.	.	.	.	.	4 mm.
Diameter of penultimate whorl	.	.	.	.	.	8 mm.

DISCUSSION. This species bears a general resemblance to *Mathilda coxi*, but differs in the more anterior position of its carinae and the narrower space separating them, as well as in other details of ornament.

OCCURRENCE. Albian, Greensand, Blackdown, Devon.

INCERTAE SEDIS

"Turritella" turbinata J. de C. Sowerby

(Pl. 32, figs. 26, 27 ; Text-fig. 19)

1850. *Turritella turbinata* J. de C. Sowerby, in Dixon, p. 349, pl. 29, fig. 2.

HOLOTYPE. In the British Museum (Natural History), reg. no. 44520.

DESCRIPTION. The shell is large and phasianelliform. The earlier whorls, up

to a diameter of about 15 mm., are not preserved in the specimens studied. The outline of the later whorls is strongly convex except for a slight concavity near the posterior suture, the diameter of those forming the spire being almost three times their height. The whorls are ornamented with about 40 spiral threads which are finely serrated and separated by interspaces equal to or narrower than their own width. The threads are of equal strength except for the most posterior six to eight, which are more prominent than the rest. The base is convex, with a rounded periphery, and is crossed by spiral threads similar to those on the outer face of the whorls. The apertural margin is not preserved intact in the available specimens, but, so far as can be seen, it was evenly rounded anteriorly. The growth-lines have a broad, shallow sinus, and a point of inflection near each suture; the growth-line chord is almost orthocline (Text-fig. 19).

Measurements of Largest Specimen Examined (B.M., no. 98208):

Height (allowing for missing apex)		6.115 mm.
Spire angle		34°
Height of penultimate whorl		23 mm.
Diameter of penultimate whorl		52 mm.

DISCUSSION. In the holotype the last whorl has been distorted by pressure in a direction parallel to the axis of the shell, with the result that its height has been reduced and the convexity of its outline increased. The specimen of which the measurements are quoted above seems to be undistorted, but the convexity of the later part of the last whorl at the periphery is stronger than that of the spire whorls.

This species appears to belong to a new genus which probably should be excluded from the Turritellidae. Until more perfect specimens are available, however, no adequate definition of this genus could be given. In its large size and *Phasianella*-like shape *T. turbinata* recalls the long-ranging Jurassic species *Bourguetia saemanni* (Oppel) (*B. striata* (J. Sowerby)), in which, however, the growth-lines are scarcely arched and slightly opisthocline and the last whorl and aperture are proportionately higher. *Bourguetia* is referred to the family Pseudomelaniidae, from which, however, the growth-lines would appear to exclude *T. turbinata*.

OCCURRENCE. Cenomanian, Chalk Marl, Sussex (holotype). Same formation, Ventnor, Isle of Wight.

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EXPLANATION OF PLATES

Specimens with numbers prefixed by BM, GSM, or SM are preserved in the British Museum (Natural History), London, the Geological Survey and Museum, London, and the Sedgwick Museum, Cambridge, respectively. Where specimens are preserved on a block of matrix, the vertical line indicates the length of the actual shell.

PLATE 28

- FIG. 1. *Turritella (Torquesia) tamra* sp. nov. Aptian, Lower Greensand, Atherfield Clay Series (bed known as the "Crackers"), near Atherfield, Isle of Wight. Holotype (bottom right-hand specimen) and paratypes. SM, B. 27329-30. $\times 2$. p. 185
- FIG. 2. *Turritella (Torquesia) hassani* sp. nov. Cenomanian Limestone (bed B of Jukes-Browne), "near Seaton, Devon". Holotype. BM, G. 49907. $\times 2$. (See also Pl. 29, fig. 9.) p. 189
- FIG. 3. *Turritella (Turritella) unicarinata* (S. Woodward). Upper Chalk, Lisburn, Co. Antrim, Ireland. GSM, 93759. $\times 2$ p. 182
- FIG. 4. Same species, basal view. Same locality. GSM, 93755. $\times 2$.
- FIG. 5. Same species. Upper Chalk, White limestone, Northern Ireland. GSM, 28256. $\times 1\frac{1}{2}$.

